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## Regional Seismic Travel-Time Prediction, Uncertainty, and Location Improvement in Western Eurasia

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We investigate our ability to improve regional travel-time prediction and seismic event location using an *a priori* three-dimensional velocity model of Western Eurasia and North Africa: WENA1.0 [Pasyanos *et al.*, 2004]. Our objective is to improve the accuracy of seismic location estimates and calculate representative location uncertainty estimates. As we focus on the geographic region of Western Eurasia, the Middle East, and North Africa, we develop, test, and validate 3D model-based travel-time prediction models for 30 stations in the study region. Three principal results are presented. First, the 3D WENA1.0 velocity model improves travel-time prediction over the *iasp91* model, as measured by variance reduction, for regional *Pg*, *Pn*, and *P* phases recorded at the 30 stations. Second, a distance-dependent uncertainty model is developed and tested for the WENA1.0 model. Third, an end-to-end validation test based on 500 event relocations demonstrates improved location performance over the 1-dimensional *iasp91* model.

Validation of the 3D model is based on a comparison of approximately 11,000 *Pg*, *Pn*, and *P* travel-time predictions and empirical observations from ground truth (GT) events. Ray coverage for the validation dataset is chosen to provide representative, regional-distance sampling across Eurasia and North Africa. The WENA1.0 model markedly improves travel-time predictions for most stations with an average variance reduction of 20% for all ray paths. We find that improvement is station dependent, with some stations benefiting greatly from WENA1.0 predictions (50% at APA, 28% at BKR, and 23% at NIL), some stations showing moderate improvement (13% at KEV, 12% at MAIO, and 10% at TAM), some benefiting only slightly (5% at MOX, and 4% at SAM), and some are degraded (-6% at MLR and -18% at QUE). We further test WENA1.0 by comparing location accuracy with results obtained using the *iasp91* model. Again, relocation of these events is dependent on ray paths that evenly sample WENA1.0 and therefore provide an unbiased assessment of location performance. A statistically significant sample is achieved by generating 500 location realizations based on 5 events with location accuracy between 1 km and 5 km. Each realization is a randomly selected event with location determined by randomly selecting 5 stations from the available network. In 340 cases (68% of the instances), locations are improved, and average mislocation is reduced from 31 km to 26 km. Preliminary test of uncertainty estimates suggest that our uncertainty model produces location uncertainty ellipses that are representative of location accuracy. These results highlight the importance of accurate GT datasets in assessing regional travel-time models and demonstrate that an *a priori* 3D model can markedly improve our ability to locate small magnitude events in a regional monitoring context.